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(71)(72) Applicant and Inventor: ENOS, Philip, Rudolph [GB/GB]; 48 Claremont Street, Rotherham S61 2LS (GB).

(74) Agent: ATKINSON, Ralph; Atkinson & Co., The Technology Park, 60 Shirland Lane, Sheffield S9 3SP (GB).

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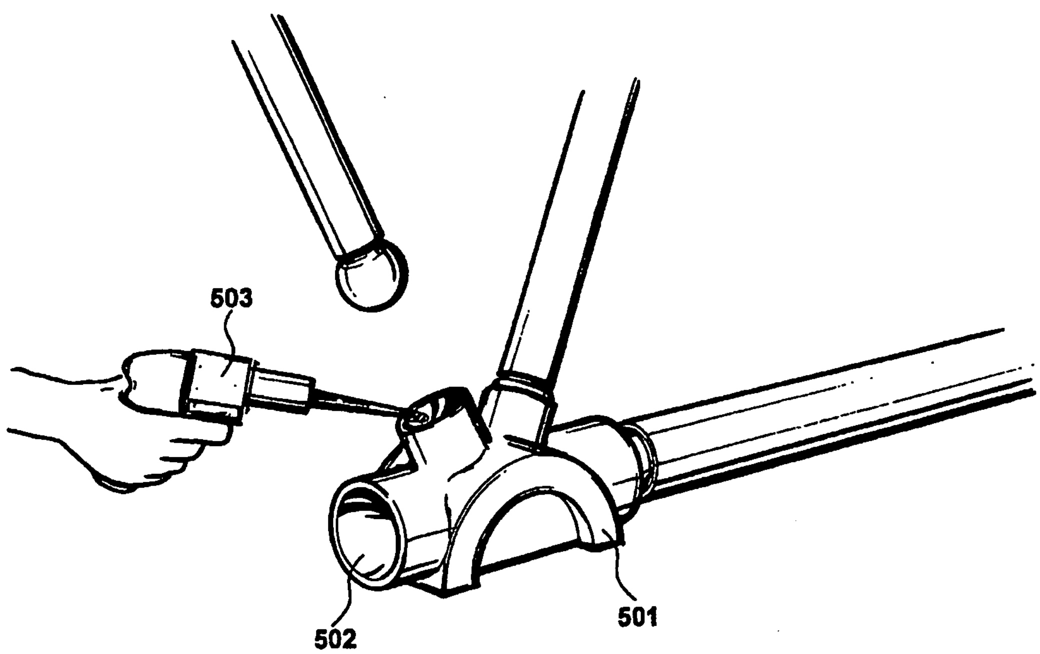
(54) Title: STRUCTURAL TRUSS



(57) Abstract

A structural truss or frame has a plurality of longitudinal support members (101) held together by a plurality of nodal members (501). Each of the support members (101) is constructed from a fibrous composite material (such as a carbon fibre/epoxy composite) defining a hollow tube. A connection between a fibrous tube (101) and a nodal member (501) is configured so as to provide a substantially uniform distribution of load in an axial direction along the longitudinal members (101).

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Structural Truss

The present invention relates to a structural truss or frame having a plurality of longitudinal support members held together by a plurality of nodal members.

The architectural possibilities for structural trusses and for space frames configured from such trusses are limited predominantly by engineering constraints, such as the strength and durability of available building materials. Thus, the design of structures of this type is limited by the strength and self-weight of the materials involved. Often, lighter materials may be considered as having advantages over more conventional materials but often these advantages are off-set by additional costs. Thus, for many constructions, designers are limited to the more conventional materials of high tensile steel and high density aluminium alloys.

Fibrous composite materials, such as carbon fibre in combination with epoxy resin are known. Materials of this type have been used in high performance, high value applications (such as in the construction of racing car bodies and military aircraft) where a whole monocoque may be moulded and cured individually for each particular application. Carbon fibre monocoques have known advantages and provide a very strong shell with significantly less weight than more conventional materials such as aluminium. However, a problem with constructing monocoque arrangements of this type is that they are prohibitively expensive and only lend themselves to constructions of modest size.

A framework made from thin-walled round composite fibre rods is disclosed in United States Patent 5,357,729. The disclosed framework is formed from a plurality of thin-walled round composite fibre rods having a pressure resistant foam core. The rod walls include at least one layer of axially parallel fibres and the framework is constructed from strut rods, transverse rods and joint plates which are operative for constructing the strut

rods to the transverse rods. The joint plates are formed from a composite fibre material. Axially parallel recesses are provided within the walls of the strut rods, and the recesses have a width corresponding to the thickness of the joint plates. The recesses extend diagonally through the foam core of the strut rods, and the joint plates are inserted into the recesses where they are glued in place. The transverse rods are provided with slots in the ends thereof. The joint plates are inserted into the slots and glued to join the strut rods to the transverse rods.

A problem with the arrangement shown in the aforesaid patent is that significant forces are created at the position of the joints. Furthermore, there is no provision for allowing the structure to find a natural and most resilient orientation given that firm fixtures are provided at the position of the joints. Furthermore, weakening is created at the joints due to the position of bolts extending through holes in the rods in order to secure the joint plates.

According to an aspect of the present invention, there is provided a structural truss or frame having a plurality of longitudinal support members held together by a plurality of nodal members, wherein each of said support members is constructed from a fibrous composite material defining a hollow tube; and the connection between a fibrous tube and a nodal member is configured so as to provide a substantially uniformed distribution of load in an axial direction.

Preferably, the connection between a fibrous tube and a nodal member is defined by a ball being received within a socket and said ball may be retained in said socket by means of a glue. Preferably, said ball extends from said longitudinal members and sockets are defined by said nodal members. Elements may connect to both ends of said longitudinal members to define said balls and said longitudinal members may be hollow tubes of substantially circular cross-section such that said elements may be received within said tubes. Preferably, the elements are tapered and said hollow tube defines a similar taper to limit the extent to which an element is received

within a tube. Each element may define a circumferencial groove portion between its tapered portion and its ball end.

According to a second aspect of the present invention, there is provided a method of assembling a structural truss or frame having a plurality of longitudinal support members held together by a plurality of nodal members, comprising the steps of constructing longitudinal support members from fibrous composite materials so as to define a hollow tube; and connecting said fibrous tube by means of nodal members wherein said nodal members are configured so as to provide a substantially uniform distribution of load in the axial direction of said longitudinal support members.

The invention will now be described by way of example only with reference to the accompanying drawings.

Figures 1A and *1B* show a spiral wound carbon-fibre/epoxy tube;

Figure 2 shows ball-end spigots arranged to be secured to the tube shown in *Figure 1*;

Figure 3 shows a spigot of the type shown in *Figure 2* bonded into position within a tube of the type shown in *Figure 2*;

Figure 4 shows a basic assembly comprising a carbon-fibre tube of the type shown in *Figure 1*, having spigots of the type shown in *Figure 2* secured at either end;

Figure 5 shows basic assemblies of the type shown in *Figure 4* being secured to a node;

Figure 6 shows a node of the type shown in *Figure 5* secured within a jig so as to ensure the correct mounting of bonded basic assemblies;

Figure 7 shows the node of *Figure 6* having a full complement of basic assemblies attached thereto;

Figure 8 illustrates a truss fabricated from a plurality of nodes of the type shown in *Figure 6*, with termination nodes for connection to other trusses or assemblies;

Figure 9 shows an alternative embodiment in which the number of connections present is reduced by the use of a saddle-node;

Figure 10 shows a second alternative embodiment in which carbon-fibre tubes are connected directly to nodes without the use of ball-end spigots;

Figure 11 shows a third alternative embodiment in which tubes are connected to nodes by means of detachable collets; and

Figures 12A, 12B and *12C* show a fourth alternative embodiment to facilitate assembly and reassembly.

A spiral wound carbon fibre/epoxy tube **101** is shown in *Figure 1A*. Tube **101** has an outer diameter **102** typically ranging from 12 mm to 300 mm, the actual value being determined in response to a particular application. In the example construction shown herein, tubes having an outer diameter of 100mm and 150mm are employed, with a wall thickness of between 6 to 15mm.

End **104** of tube **101** is shown enlarged in *Figure 1B*. The tubes are wound on mandrills that determine the internal diameter of the tube with the total thickness of the tube being determined by the thickness of the windings, the number of windings and to a lesser extent the nature of the windings. In the example shown, the tubes have been wound in alternating directions at an angle of around forty-five degrees. The fibres have an external diameter of typically seventeen micro-metres and the resin system is an epoxy of the bi-phenol A/F type, post cured to provide maximum mechanical properties. Once cured, mechanical testing may be performed upon the tubes so as to confirm their mechanical strength, resulting in the establishment of (Youngs) moduli comparable with more conventional materials.

In the example shown in *Figure 1B*, the tube has been left with a wound surface finish, typical of small bore epoxy pipes. However, a glossy resin-rich finish is preferably to improve weathering characteristics.

For most applications, a winding angle of forty-five degrees provides the optimum level of strength. By increasing the winding angle, with reference to the central axis, the fibres are brought more closely together along said axis resulting in the compressive strength characteristics of the tube being improved, at the expense of its tensile characteristics. Alternatively, windings made at an angle of less than 45 degrees with reference to the central axis, thereby laying more parallel with said central axis, provide improved tensile characteristics, at the expense of their compressive strength.

Tube **101** is cut to a requisite length **103**, whereafter internal tapers are machined at either end **104**, **105**. Internal tapers **104**, **105** co-operate with spigots **201** or **202**, as illustrated in *Figure 2*. Spigot **201** is fabricated from drop-forged aluminium, whereas spigot **202** is fabricated from an injection moulded or cast plastic. Each spigot **201** includes a tapered portion **203**, a ball-end portion **204** and a circumferencial groove **205**.

Each internal taper **104**, **105** of a spiral wound tube **101** receives the tapered portion **203** of a spigot **201**, which is secured therein by epoxy glue or an alternative bonding agent such as cyanocrylate. A taper angle of between two and five degrees is provided, with a preferred angle being three degrees. Thus, the tapered angle ensures that the spigot **201** is held firmly in place when pushed as far as it will go against the internal tapers of tube **101**. Spigot **201** is held firmly within tube **101** by means of a two-component epoxy resin, such as that supplied by CIBA Geigy. Preferably, the glue is of a low hysterisis type, ensuring that it is runny enough to cover all of the surfaces that are being glued together.

Glue technology of this type is now sufficiently advanced such that the glue weld is at least as strong as the materials being bonded together. Furthermore, bonding times may be specified, typically ranging from seconds to hours, so as to provide sufficient time for the assembly to be placed into position before the glue weld becomes secure.

A cross-section of a spigot **201** secured within a tube **101** is shown in *Figure 3.* The spigot **201** is held firmly in position by means of epoxy glue **301**. Furthermore, a three-degree taper, illustrated by angled line **302**, ensures that the spigot **201** is held firmly in position by tube **101**. Spherical insert portion **204** is received within spherical voids of nodes illustrated subsequently. Groove **205** provides assembly clearance, thereby ensuring that the tube end effectively runs out before it can impinge upon the shoulders of the spherical portion **204**.

A basic assembly, consisting of a length of carbon fibre tube **101** with spigots **201** secured at either end is illustrated in *Figure 4.* As previously stated, the length of the assembly and its diameter could have many values, dependent upon a particular application. Similarly, the spigots **201** would be sized proportionally with the diameter of the tubes for which they are intended.

A truss is assembled from a plurality of basic assemblies **101**, connected by nodal members. A plurality of trusses may then be combined to form a complete construction. In simple trusses, all of the members may be of similar proportions. However, in most trusses, not all members are carrying similar forces and the size and durability of basic assemblies may be modified accordingly. Furthermore, by incorporating appropriately wound tubes **101**, account may be taken of estimated compressive, tensile and shear forces, so as to provide the requisite strength and rigidity while avoiding unnecessary weight and expense. It is also appreciated that by minimising weight and optimising the design, the overall level of forces contained within the structure are reduced, thereby facilitating additional improvements and enhancements which provide many advantages of varying importance depending upon the application of the finished construction.

A significant advantage of structures assembled from the carbon-fibre members disclosed herein is that the sizes of members required to provide a

particular structure having a specified strength are significantly lower than equivalent structures fabricated from steel. Thus, for example in structures constructed using large areas of glass, the supporting members may be small and therefore become less visible allowing a larger proportion of the surface area to be perceived as transparent.

The surface finish of the structure is also noticeably different from that provided by similar metallic arrangements. In particular, it provides a substantially matt black appearance which is preferable in arrangements such as lighting rigs for theatrical concerts and performance applications where reflections can produce undesirable effects. In particular, for such applications, aluminium trussing is often painted with matt black paint, although this may still result in some glinting due to the paint being chipped and scratched during transit.

A truss is fabricated by securing basic assemblies of the type shown in *Figure 4* to nodes, such as node **501** shown in *Figure 5*. Nodes **501** are machined from high density aluminium alloy, or cast from a composite plastic and include a plurality of spherical voids **502**, each arranged to co-operate with a spigot **201** of a basic assembly to provide a conventional ball-joint configuration. In order to secure a basic assembly, epoxy glue is inserted within a spherical void using a glue gun **503** or similar device.

During the assembly process, basic assemblies are held at the required orientation with respect to a node **501** by means of a jig **601**. Jig **601** includes a plurality of channels **602**, each accurately positioned so as to hold a co-operating basic assembly in position with respect to a spherical void.

For a given nodal position, the angle at which a basic assembly extends from a spherical void is adjustable within a defined angle of adjustment. Adjustment of this type is facilitated by the presence of circular groove **205** in spigots **201**, thereby ensuring the movement of a basic assembly is not unnecessarily limited due to interference between its spiral wound rod and a connecting node.

A structural truss or frame has a plurality of longitudinal support members held together by a plurality of nodal members. Each of the support members is constructed from the fibrous composite material defining a hollow tube. The way in which the longitudinal support members are secured to the nodal members is highly important in order to achieve optimum strength and rigidity. As such, a connection between a fibrous tube and a nodal member is configured so as to provide a substantially uniform distribution of load in an axial direction.

A node is shown in *Figure 7* forming part of a structural truss. In the example shown in *Figure 7*, basic assemblies **701** and **702** support high compressive loads and as such are fabricated from basic assemblies having a relatively large diameter. Furthermore, assemblies **701** and **702** could be constructed from rods wound so as to enhance their compressive strength. In addition, load carrying members are separated by intermediate basic assemblies **703** and **704** having a relatively smaller diameter. Thus, basic assemblies **701** to **704** are all secured to a node **705**, using a jig of the type shown in *Figure 6*.

Node **705** forms a component node of a structural truss of the type shown in *Figure 8*. The truss includes similar nodes **801**, **802** and **803**. In its intended application, node **801** also supports major structural members conveying compressive forces. However, nodes **802** and **803** are connected to basic assemblies conveying tensile forces and, in a preferred embodiment, differently wound rods are used for these different applications.

Further nodes are used within the truss structure, with nodes **805** and **806** being configured to support three basic assemblies in relatively symmetrical orientations. Similarly, nodes **807** and **808** are configured to support two basic assemblies. Nodes **805**, **806**, **807** and **808** are also fabricated as termination nodes so as to facilitate connection to other trusses or other constructions.

Having fabricated a truss of the type shown in *Figure 8*, it is possible for this truss to be employed in the fabrication of major structures and additional connecting members are used in order to allow trusses to be connected together. Furthermore, structures of alternative configuration may be created using a substantially similar connecting technologies. Consequently, large and complex structures may be fabricated essentially from the use of nodes and basic assemblies as described herein.

An alternative embodiment is shown in *Figure 9* in which assemblies **701** and **702** shown in *Figure 7* have been replaced by a continuous assembly **901**, onto which a saddle-shaped node **902** has been bonded thereto. Saddle node **902** includes spherical voids for receiving assemblies **903** and **904**, substantially similar to assemblies **703** and **704** shown in *Figure 7*.

A second alternative embodiment is shown in *Figure 10* in which each rod **1001**, **1002** and **1003** is bonded directly to tapered extensions **1004**, **1005** and **1006** respectively of a node **1007**. In this configuration, there is no requirement for ball-end spigots but a disadvantage of the arrangement is that there is no possibility of relative movement between the rods and the nodes which may result in constructional stresses being introduced during the construction of a truss.

A third alternative embodiment is shown in *Figure 11* in which rods **1101**, **1102** and **1103** are connected to non-tapered extensions **1104**, **1105** and **1106** respectively of a node **1107** via threaded collets **1108**. A tapered end **1109** of collet **1108** is secured within rod **1101** in a fashion substantially similar to the securing of a ball-end spigot **204**. The collet is then placed over the extension **1104** and held firmly thereon by the application of locking nut **1110**.

A fourth alternative embodiment is shown in *Figure 12A*, similar to the embodiment shown in *Figure 5* and *Figure 9*. Ball-shaped spigots are received within spherical voids, thereby providing an optimum configuration

for the transfer of forces between nodes and co-operating rods. Thus, rod **1201** is received within node **1202**. However, as an alternative to gluing, a ball-end **1203** of rod **1201** is modified to define flat parallel planes such that a cavity is then created between the ball and its spherical void, into which securing pins **1204** are inserted as shown in *Figures 12B* and *12C*. Insertion of securing pins **1204** sufficiently secures the ball-end spigots within the spherical voids to the extent that it is not necessary to secure the ball-ended spigots by means of glue. In this way, it is possible for the assembly to be dismantled by the removal of pins **1204**.

An exploded view of the configuration shown in *Figure 12A* is shown in *Figure 12B*. Parallel planes **1221** and **1222** of the ball-end of spigot **1203** are shown, held in place by means of securing pins **1204**. A complete assembly, with pins **1205** in place, is shown in *Figure 12C*.

Claims

1. A structural truss or frame having a plurality of longitudinal support members held together by a plurality of nodal members, wherein each of said support members is constructed from a fibrous composite material defining a hollow tube; and

a connection between a fibrous tube and a nodal member is configured so as to provide a substantially uniform distribution of load in an axial direction.

2. A structural truss according to claim **1**, wherein said connection between a fibrous tube and a nodal member is defined by a ball being received within a socket.

3. A structural truss according to claim **2**, wherein said ball is retained in said socket by means of a glue.

4. A structural truss according to claim **2** or claim **3**, wherein said ball extends from said longitudinal members and sockets are defined by said nodal members.

5. A structural truss according to claim **4**, wherein elements connect to both ends of said longitudinal members to define said balls.

6. A structural truss according to claim **5**, wherein said longitudinal members are hollow tubes of substantially circular cross-section and said elements are received within said tubes.

7. A structural truss according to claim **6**, wherein said elements are tapered and said hollow tube defines a similar taper to limit the extent to

which an element is received within a tube.

8. A structural truss according to claim **7**, wherein each element defines a circumferencial groove portion between its tapered portion and its ball end.

9. A method of assembling a structural truss or frame having a plurality of longitudinal support members held together by a plurality of nodal members, comprising the steps of

constructing longitudinal support members from fibrous composite materials so as to define a hollow tube; and

connecting said fibrous tube by means of nodal members wherein said nodal members are configured so as to provide a substantially uniform distribution of load in the axial direction of said longitudinal support members.

10. A method according to claim **9**, wherein the connection between a fibrous tube and a nodal member is defined by the location of a ball within a receiving socket.

11. A method according to claim **10**, wherein said ball is retained within said socket by means of a glue.

12. A method according to claim **10** or claim **11**, wherein said ball extends from said longitudinal member and sockets are defined by said nodal members.

13. A method according to claim **12**, wherein elements are connected to both ends of said longitudinal members so as to define said balls.

14. A method according to claim **13**, wherein said longitudinal members are hollow tubes of substantially circular cross-section and said elements are received within said tubes.

15. A method according to claim **14**, wherein said elements are tapered and said hollow tubes define similar tapers to as to limit the extent to which an element is perceived within a tube.

16. A method according to claim **15**, wherein each element defines a circumferencial groove portion between its tapered portion and its ball end.

17. A structural truss or frame substantially as herein described with reference to the accompanying drawings.

18. A method of fabricating a structural truss or frame substantially as herein described with reference to the accompanying drawings.

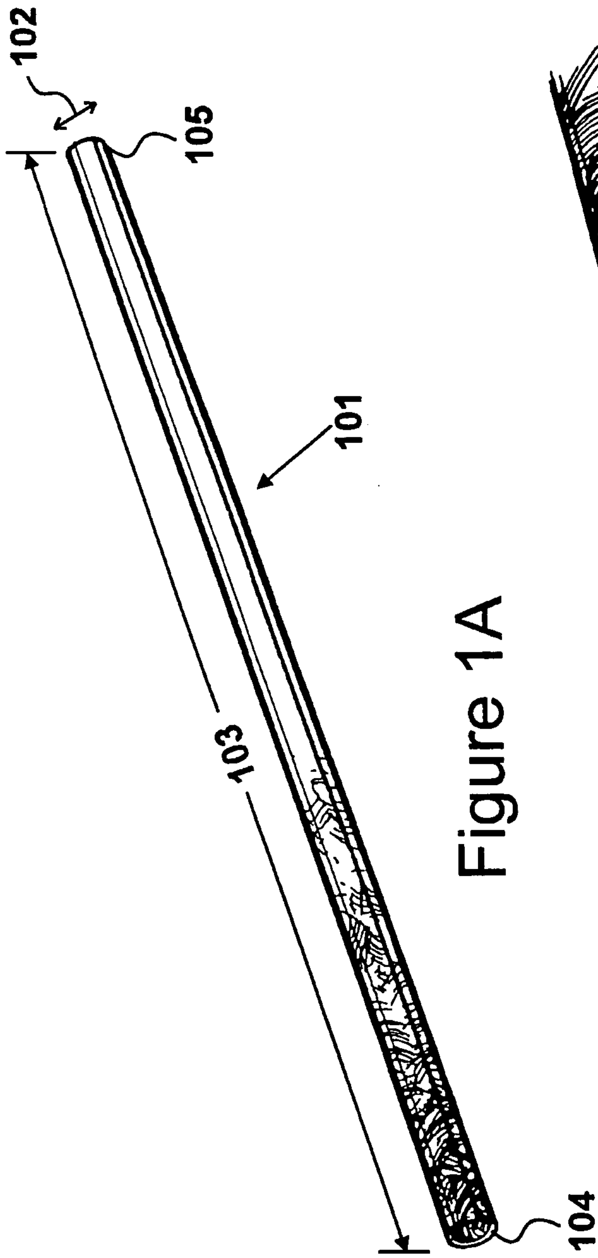

Figure 1A

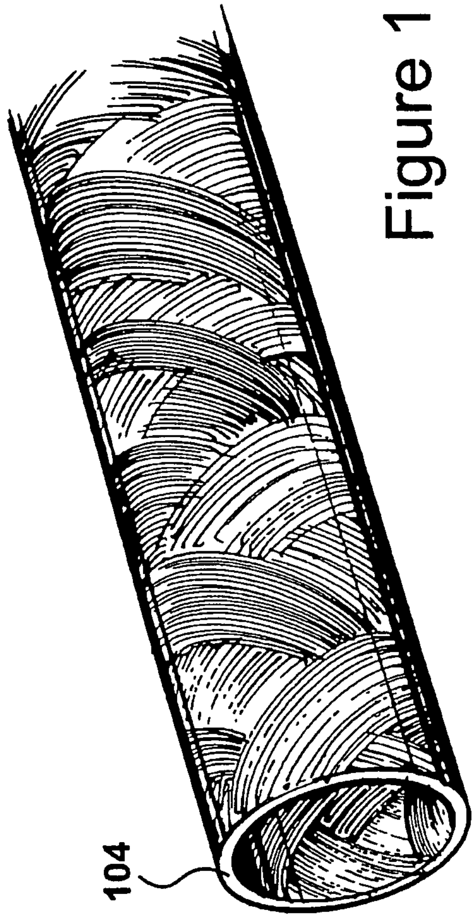

Figure 1B

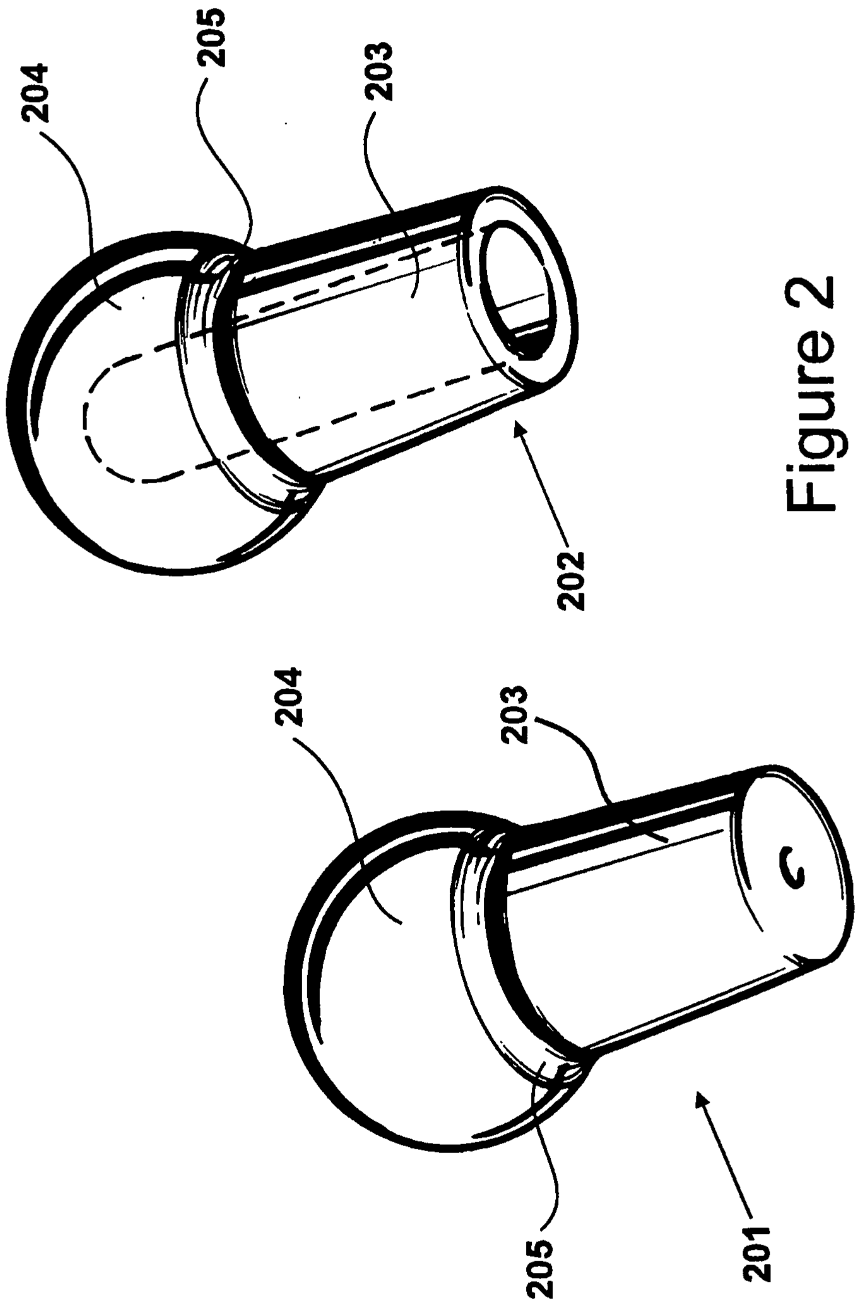

Figure 2

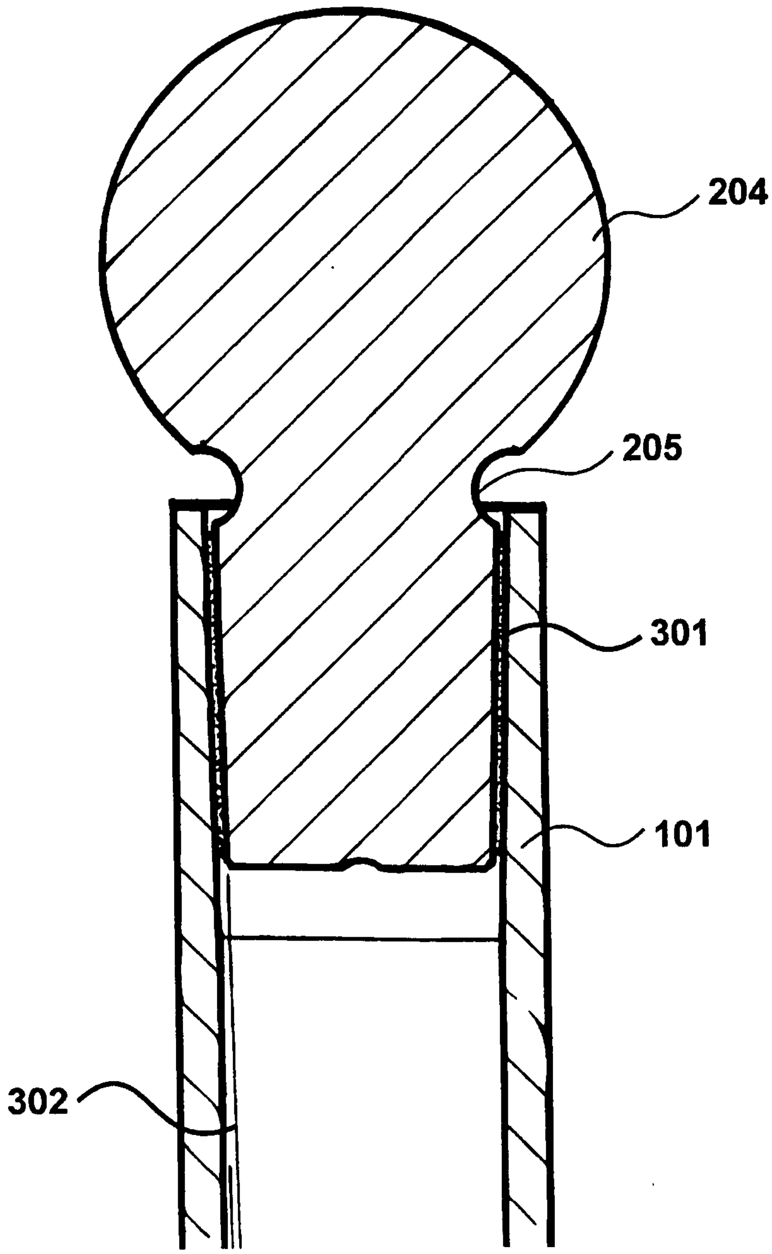

Figure 3

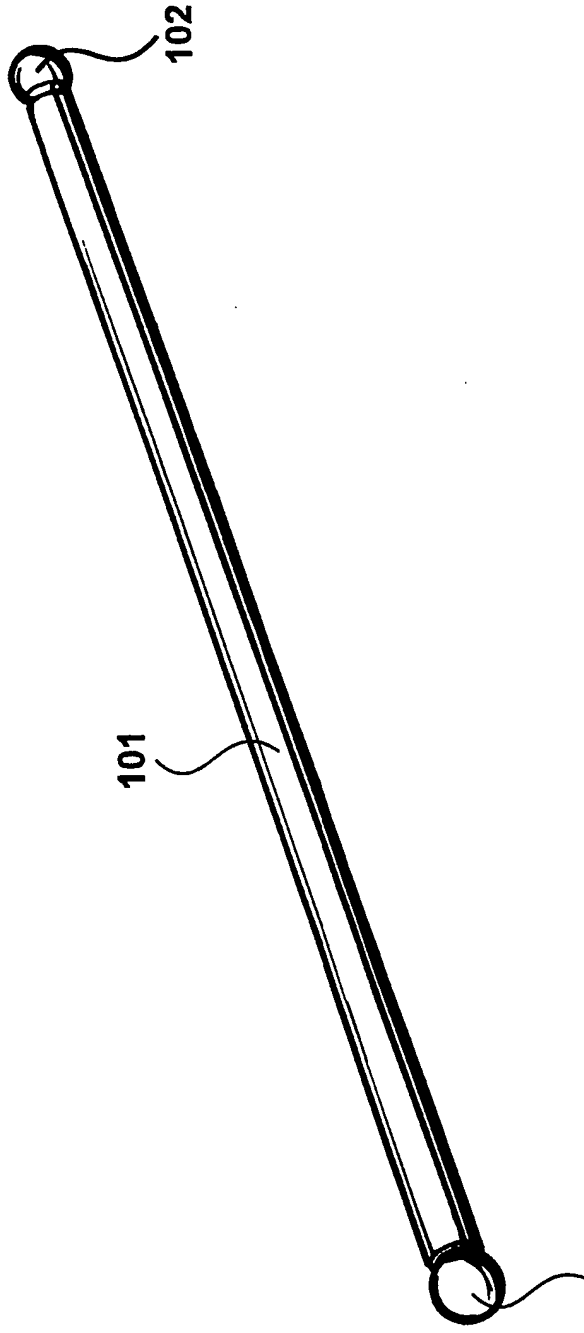

Figure 4

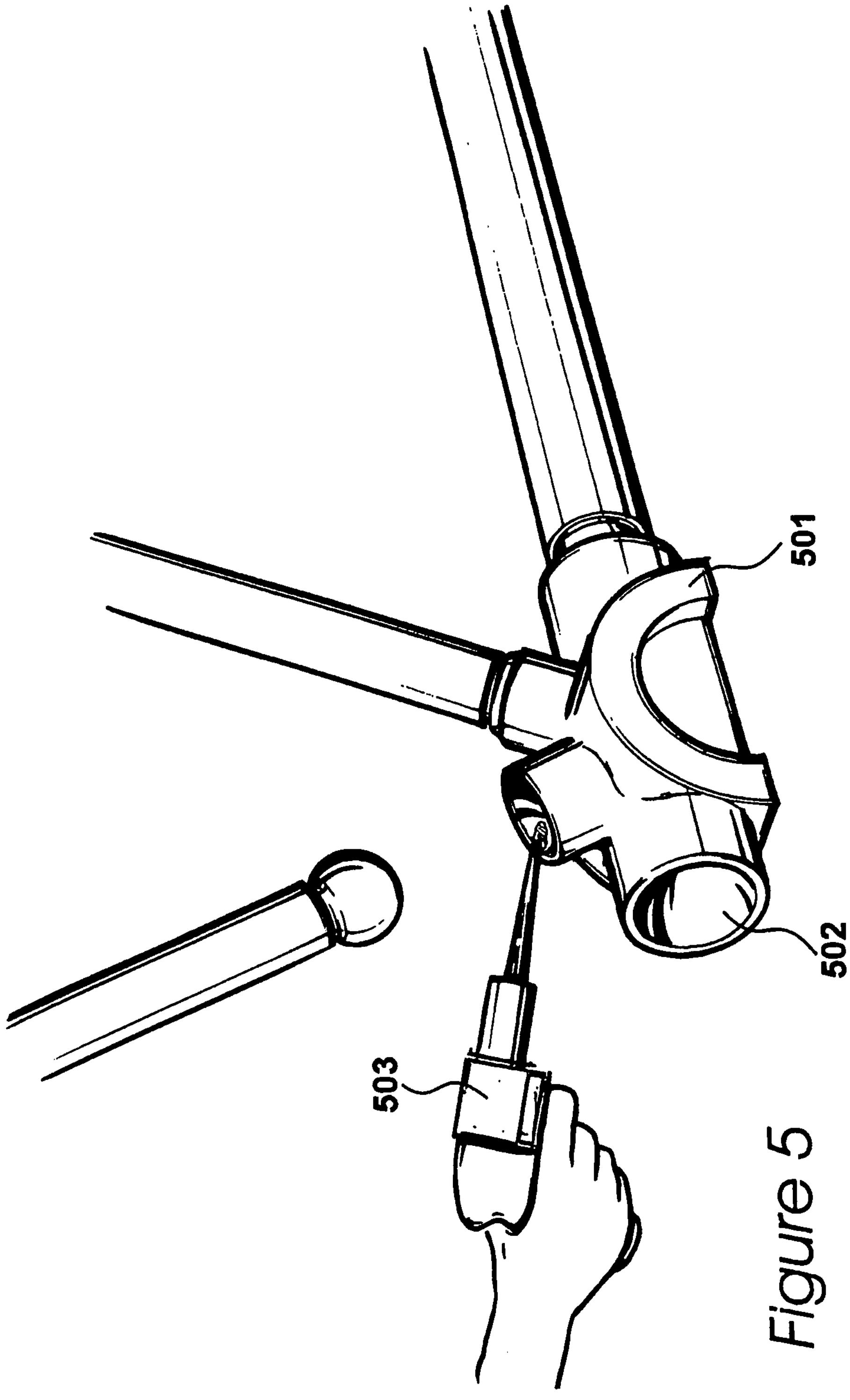

Figure 5

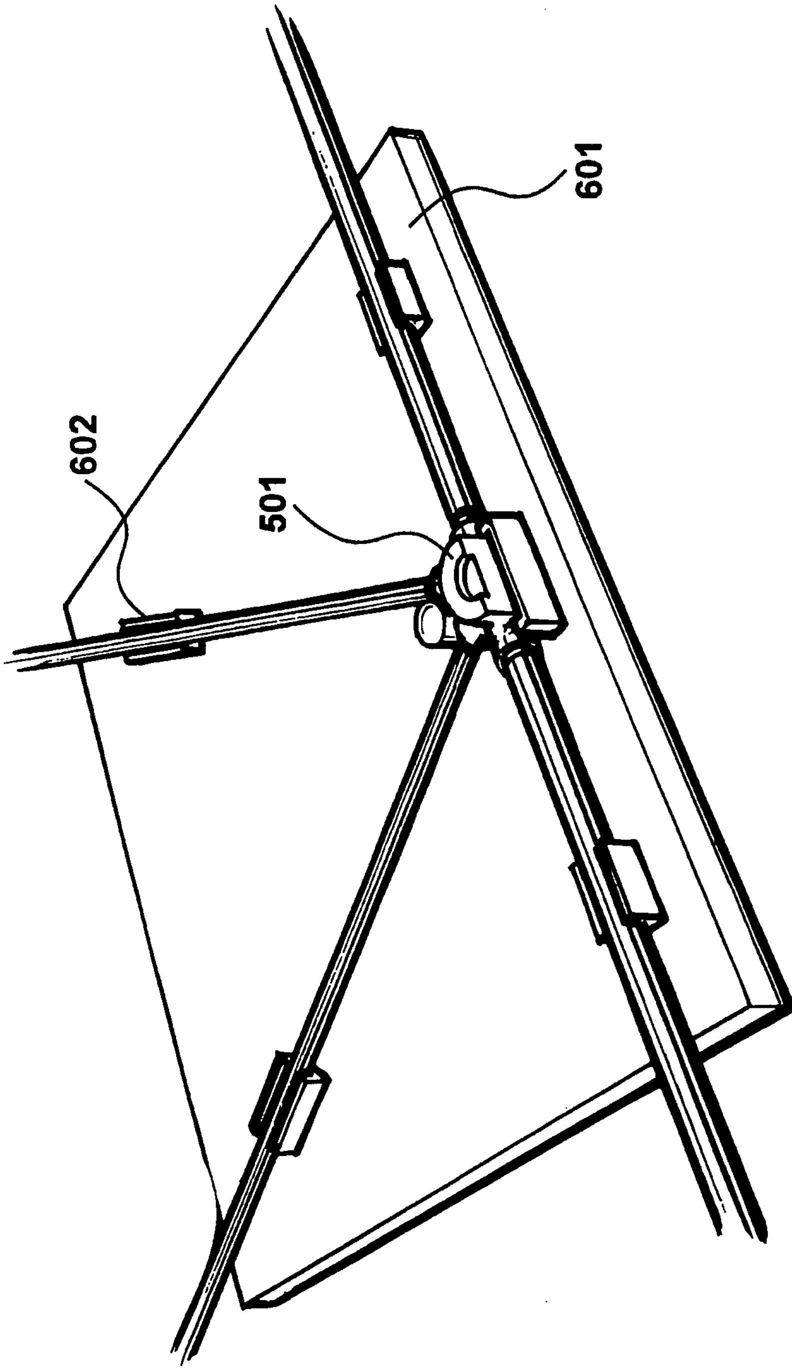

Figure 6

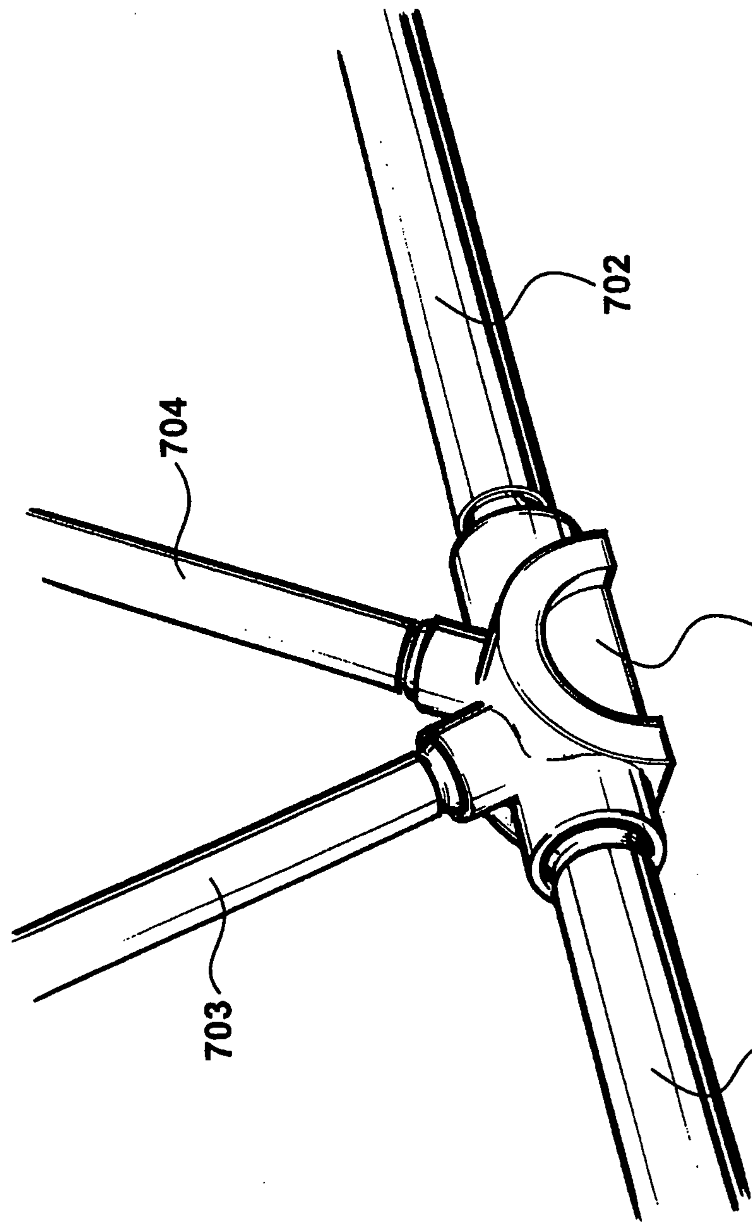

Figure 7

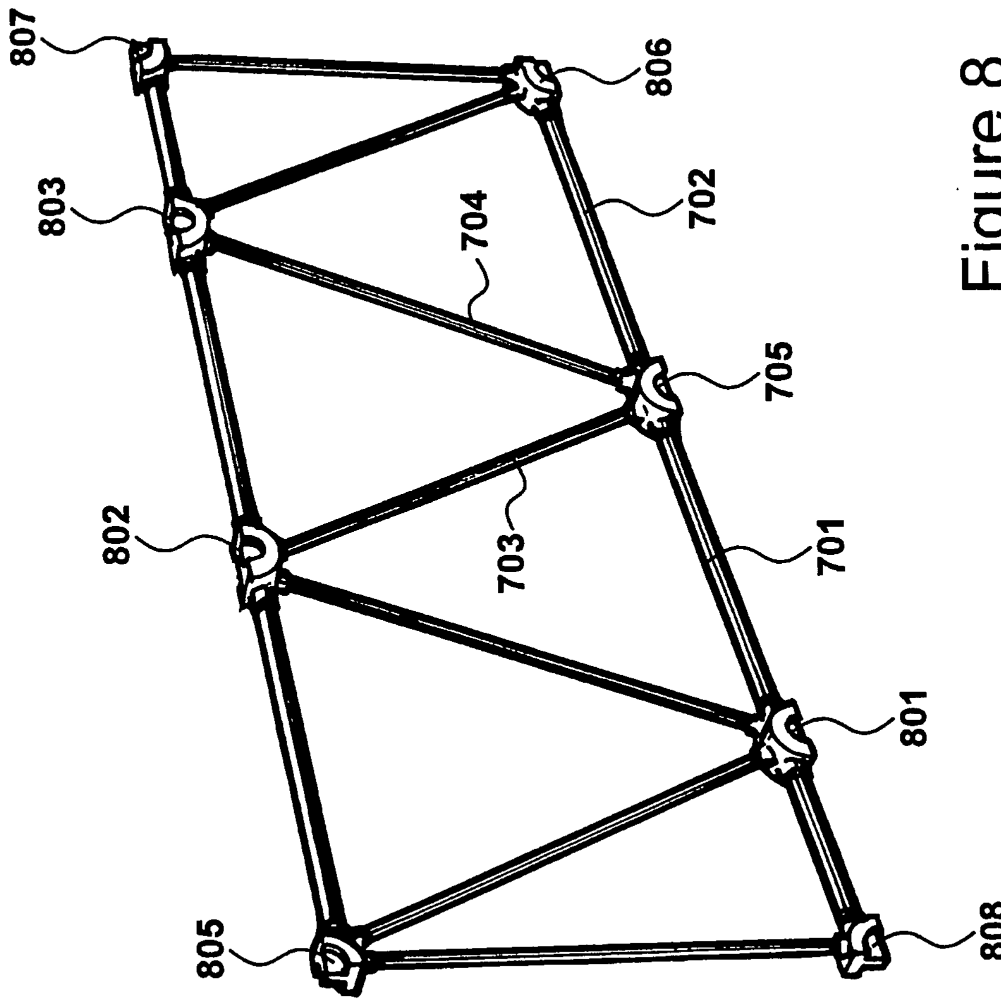

Figure 8

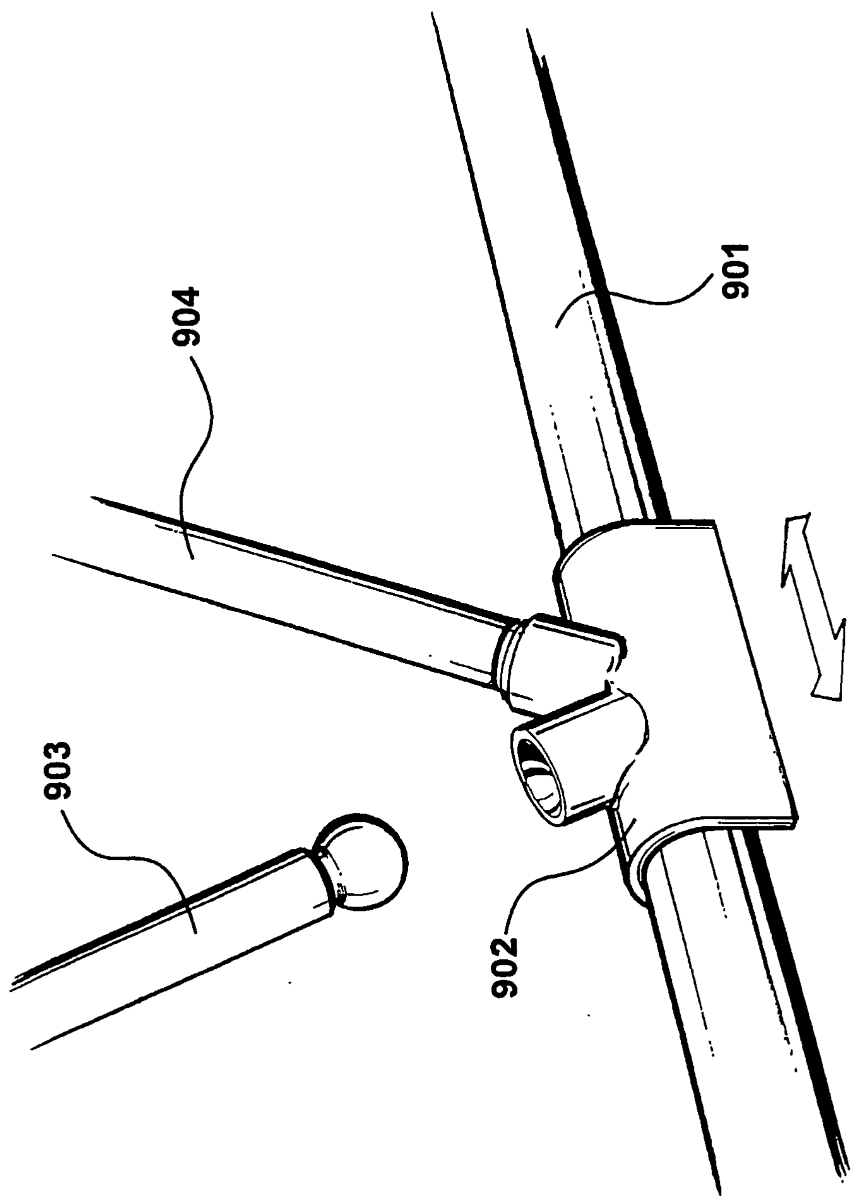

Figure 9

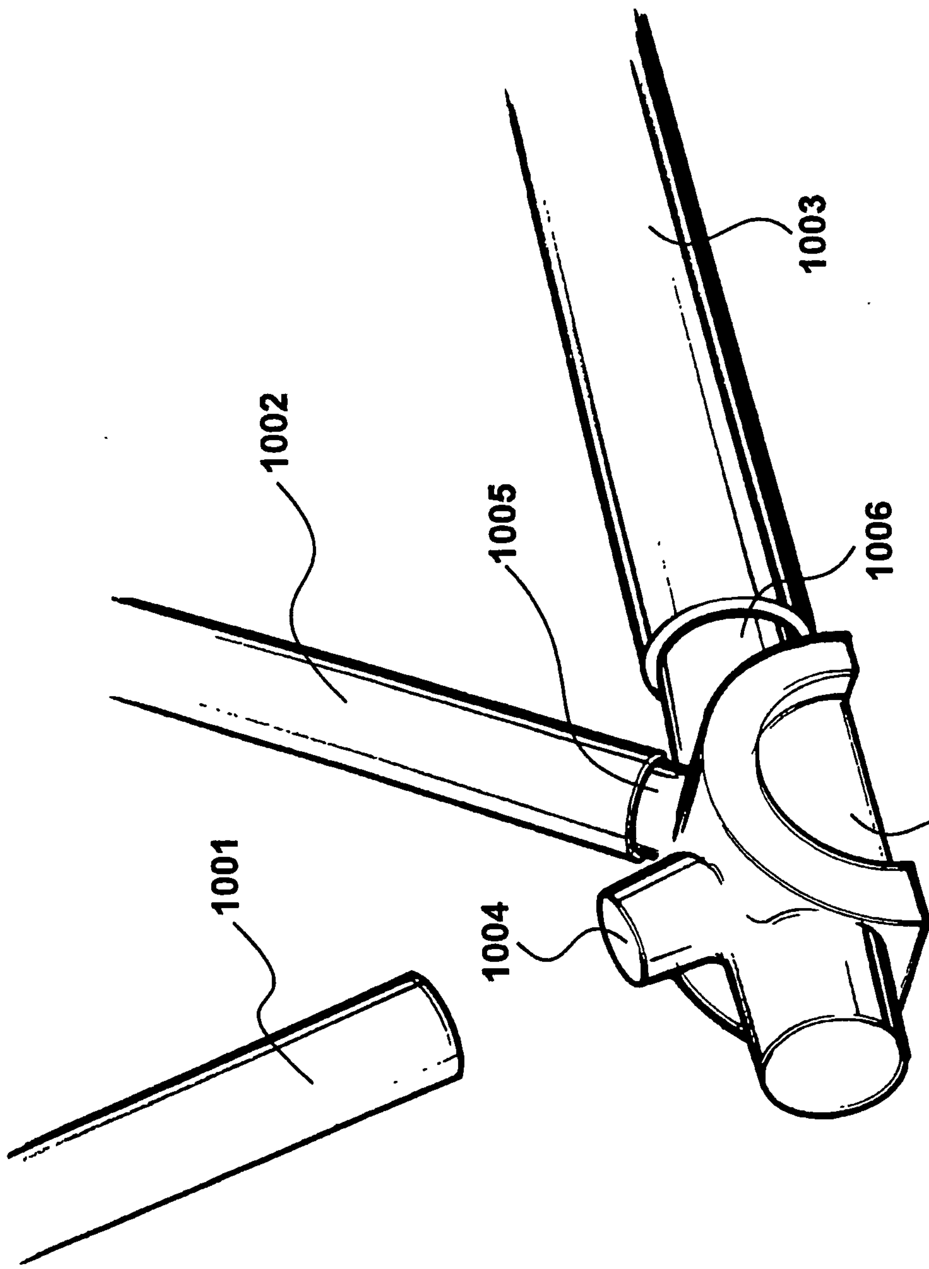

Figure 10

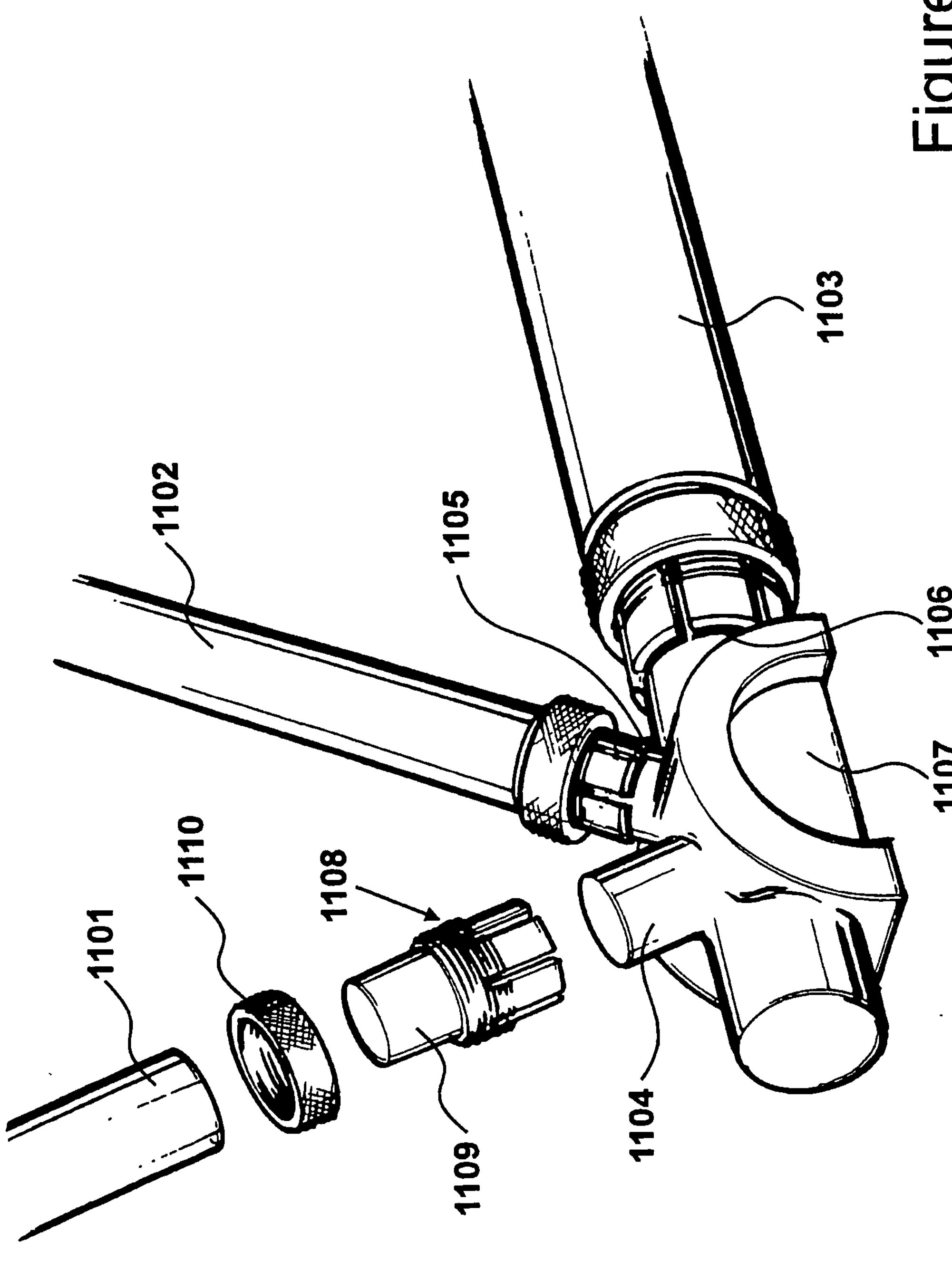

Figure 11

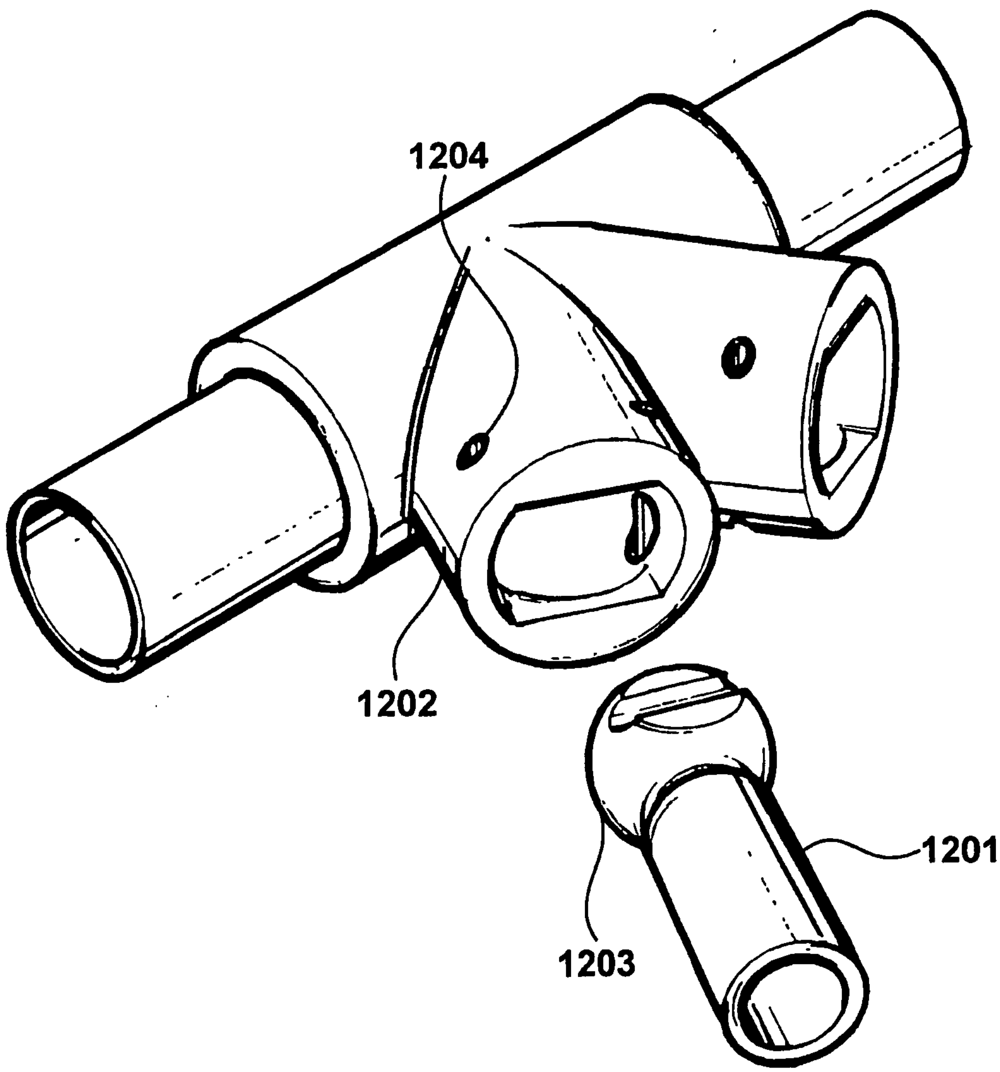

Figure 12A

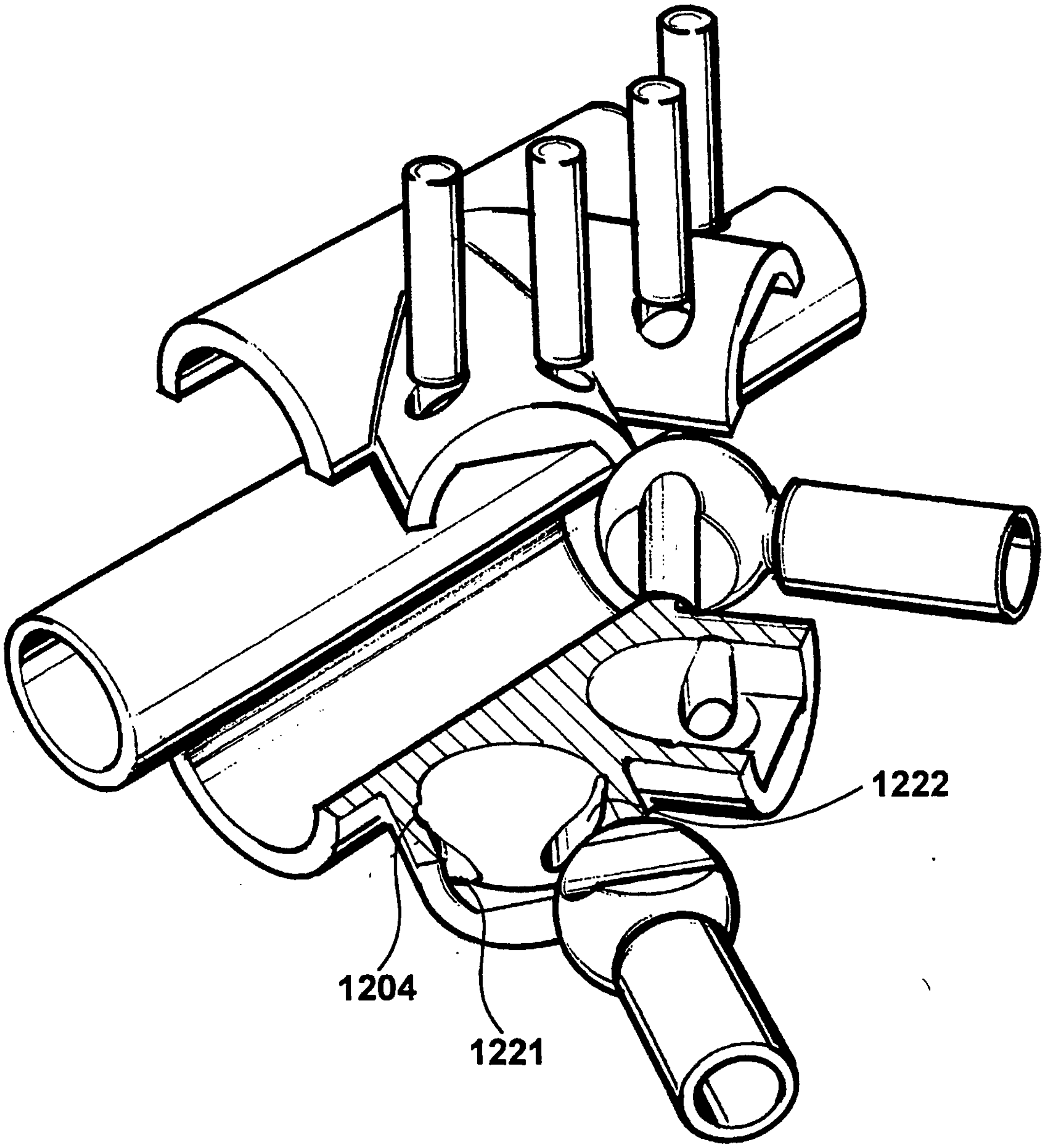

Figure 12B

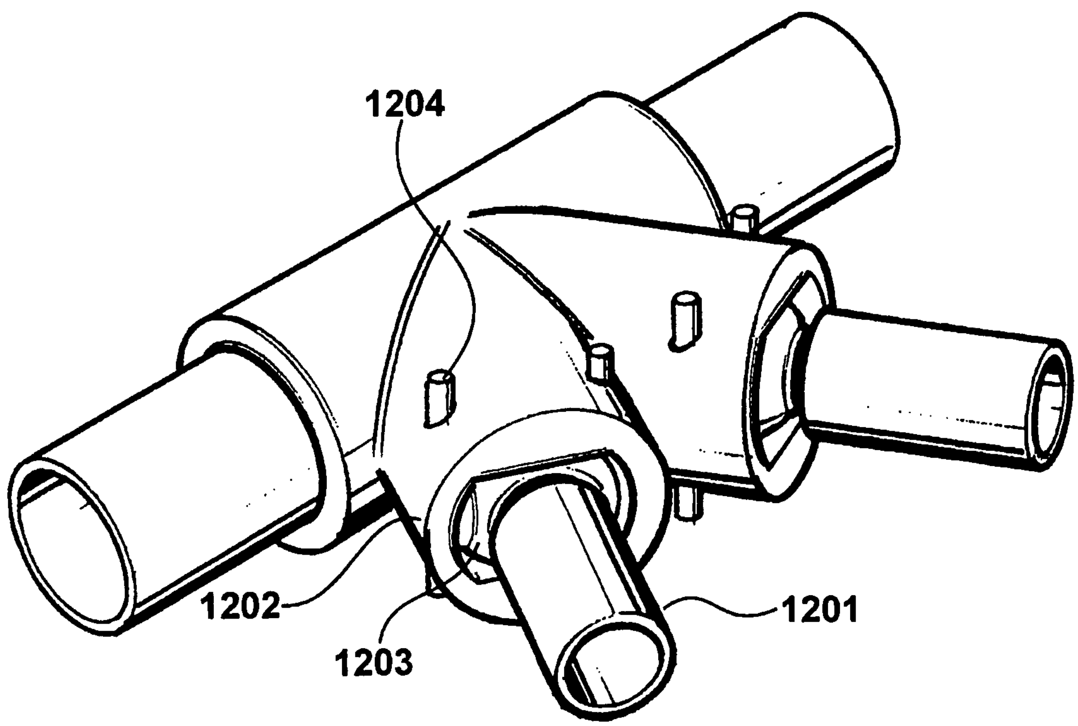

Figure 12C

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 99[illegible]47

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 E04C3/28 F16B11/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 E04C F16B E04B E04H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	US 3 100 555 A (ASHTON) 13 August 1963 see column 2, line 28 - column 5, line 5; figures	1,9 3,5-7, 11,13-15
A	US 5 088 852 A (DAVISTER) 18 February 1992 see claims; figures	1,2,9,10
A	DE 24 21 758 B (HORN) 6 March 1975 see claims; figures	1,2,9,10
A	DE 196 13 090 A (LUFTSCHIFFBAU ZEPPELIN) 10 October 1996 see the whole document	1,9
A	EP 0 053 534 A (LABOR. D'ETUDES ET DE RECHERCHES CHIMIQUES) 9 June 1982 see the whole document	1,9

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☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
2 July 1999	09/07/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Vijverman, W

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 99/[illegible]47

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
US 3100555	A	13-08-1963	NONE			
US 5088852	A	18-02-1992	NONE			
DE 2421758	B	06-03-1975	NONE			
DE 19613090	A	10-10-1996	IT	T0960272	A	06-10-1997
			FR	2732664	A	11-10-1996
			GB	2300010	A,B	23-10-1996
			JP	9156597	A	17-06-1997
			ZA	9602756	A	09-10-1998
EP 53534	A	09-06-1982	FR	2495275	A	04-06-1982
			AT	12560	T	15-04-1985
			CA	1183319	A	05-03-1985
			US	4437288	A	20-03-1984